A COMPARATIVE STUDY OF ANTHROPOMETRIC AND ELECTROMYOGRAPHICAL DIFFERENCES BETWEEN FRONT-ON AND SIDE-ON MALE FAST BOWLERS

By

Jatin Bhosle

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Synopsis

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Chapter-I: Introduction

Cricket is a widely played sport in modern times. The fascinating nature of this game has attracted the attention of spectators all around the world. Although a cricket stadium is filled with thousands of spectators, millions of people around the world enjoy the game of cricket live on television too. According to a media report released by ICC (International Cricket Council) in September-2019, the global cumulative average of audience 1.6 billion people around the world watched the live coverage of the 2019 edition of the Men's cricket world cup.

It is notable to mention that the modern term 'cricket' is said to be derived from the French word 'críquet' which means a 'wooden gate' (Altham & Swanton, 1948). Deriving the term from French, however, there are other arguments that state that cricket was 'invented' in England. An argument states that cricket has Celtic origins (Bowen, 1970). However, spectators around the world have accepted Cricket as one of their favorites, and the introduction of limited-overs cricket has multiplied the interest of sports enthusiasts throughout the world. India, being one of the most dominant nations in the game of cricket, has emerged as world cup champion in limited-overs one-day cricket in 1983 and 2011, runner-up in 2003 world cup, and also a T20 world cup winner in 2007. Also, the Indian cricket team was runner-up in the latest concluded test championship which was held from 2019-to 2021 (all sources from ICC official database). These stats pretty much sum up the level of the love this game has received in the Indian subcontinent. Not to mention that on the ground level, apart from just big cities with highly dense populations, cricket is played even in small towns and villages in the nation.

The game of Cricket is played between two teams that consist of eleven players each. It is a bat and ball game. As per ICC's laws, it is played with a wooden bat and leather ball. Skill-wise there are four major departments in cricket namely- batting, bowling, fielding, and wicket-keeping. This study focuses on bowling. As per Bob Woolmer's book "Bob Woolmer's art and science of cricket", various methods and suggestions are made for different types of bowlers i.e., fast bowlers and spin bowlers. Here it is concluded that there are two distinct approaches in cricket bowling i.e., pace (fast) bowling and spin bowling (Ahamed et al., 2014; Woolmer et al., 2008). The investigator specifically wants to study pace bowling.

Researchers have previously worked on parts of bowling action in cricket. To summarize bowling action in parts there are five major phases- the run-up, the set-up, the unfold, the delivery, and the follow-through (Woolmer et al., 2008). Another study suggests 7

precise phases in bowling i.e., run-up, pre-delivery stride, mid-bound, back-foot contact, front-foot contact, ball release, and follow-through (Ahamed et al., 2014).

When it comes to the style of pace bowling, the bowlers usually adopt one of the two styles i.e., front-on and side-on (Ahamed et al., 2014; Elliott et al., 1992; Woolmer et al., 2008). While the body remains sideways towards the target at the time of back-foot contact until the front-foot contact, the bowler happens to produce a sudden rotation of hips to generate power, a side-on bowling action is formed. While in another case (front-on), the bowler chooses to keep his chest open towards the target while delivering the ball, it comes under front-on (or open-chest) bowling action. However, while releasing the ball, both front-on and side-on bowlers face the batter chest-on, the difference is significant in quick, smooth delivery action (Woolmer et al., 2008). When these actions are classified biomechanically, shoulder alignment lesser than or equal to 190° (in another study 200°) and angle of back-foot lesser than or equal to 280° while bowling arm depicts a line drawn through leading shoulder is parallel with the surface constitutes side-on action, whereas, when the shoulder alignment is more than 190° while the back-foot angle is more than 280°, it constitutes a front-on action (Elliott et al., 1992; Foster et al., 1989).

A 2014 study on overhead-throwing athletes and cricket fast bowlers pointed that there is a very limited number of literature available on electromyography performed on cricket bowlers, specifically only four, in which only two were available online. (Ahamed et al., 2014). The need for this study arises from here.

Since the surface electromyography studies provide a biofeedback to the researcher about the muscle activity in a subject (Mehr, 2013), the recommendations about therapeutic and rehabilitation exercises as well as programmed exercise plans can be given to the sportspersons based on their muscle activation readings, and it may also be beneficial to detect and prevent injuries.

According to a study conducted in 1994, it was concluded that senior international fast bowlers produce greater ball release speed than junior international fast bowlers because the former possess higher angular velocity in dominant bowling arm (Bartlett et al., 1996).

Now, the aim of the study becomes two-fold i.e., (i) to compare muscle activation between front-on and side-on bowlers, and (ii) to compare the anthropometrics difference between front-on and side-on bowlers (through comparing ball release height between both bowling approaches).

Statement of the problem

The aim of the study will be to compare the anthropometric and electromyographic differences between two distinct bowling approaches i.e., front-on and side-on.

Research questions

1. Whether there is statistical difference of muscle activation of selected upper body muscles between front-on and side-on styles of bowlers.
2. Whether there is statistical difference of ball release height between front-on and side-on styles of bowlers.

Objectives of the study

1. The first objective of the study will be to assess the mean score of ball release height possessed by front-on fast bowlers.
2. The second objective of the study will be to assess the mean score of ball release height possessed by side-on fast bowlers.
3. The third objective of the study will be to compare the difference in terms of ball release height between these two approaches and find out whether there is significant difference between mean scores of both groups or not.
4. The fourth objective of the study will be to characterize the level of mean scores of muscle activation of front-on style fast bowlers.
5. The fourth objective of the study will be to characterize the level of mean scores of muscle activation of side-on style fast bowlers.
6. The sixth objective of the study will be to compare the group mean scores of muscle activation between front-on and side-on bowlers and find out whether there is significant difference between mean scores of both groups or not.

Hypotheses

H_{01}: It is hypothesized that there will be no significant difference between the means of ball release height of both the groups.

H_{02}: It is also hypothesized that there will be no significant difference between the mean scores of muscle activation between both the groups.

Delimitations

- The study will be delimited to 20 professional male cricket fast bowlers (side-on = 10 and front-on = 10).
- The study will be further delimited to players of age 21 (±4).
- The study will be further delimited to players who have participated in division/state/national/west-zone/all-India level cricket tournaments in order to ensure a proper technique and legal bowling action possessed by them during study.
- The ball to be used by bowlers, 4-piece red SG-Tournament (or higher quality subject to availability) Cricket leather ball, will mark a delimitation to the study.
- The study will be further delimited to anthropometric variable i.e., ball release height.
- The study will be conducted on a dry grassy surface along with a turf wicket.
- The study will be delimited to selected major muscles of upper body in bowling arm i.e.,
    - Anterior deltoid
    - Pectoralis major
    - Latissimus dorsi
    - Trapezius
    - Teres major
    - Bicep brachii
    - Tricep brachii

Definition and Explanation of terms

1. **Anthropometry:** The scientific study of the measurements and proportions of the human body.
2. **Biomechanics:** Biomechanics is the investigation of the structure, function and movement of the mechanical parts of biological systems.
3. **EMG Electromyography:** Surface Electromyography is the study of muscle function through analysis of the electrical signals originated from muscular contraction. Biomedical signals that measure electrical current generated in muscles during its contraction.
4. **BTS Free EMG Analyzer:** Electromyography device with wireless probes for the dynamic analysis of muscle activity. FREEEMG is a 4G technology device for surface Electromyography (EMG) analysis. Signal accuracy, absence of wires, lightness and reduced size of the probes are features which enables users to perform analyses of any type of movement, for each body part, without altering the natural movement of the analyzed subject.
5. **Fast Bowling:** Fast Bowling, is also called Pace Bowling is a bowling technique used in cricket. It mostly relies on the speed of the ball to dismiss the batsman.
6. **Front-on bowling action:** A shoulder alignment greater than 190° and a back foot angle greater than 280° where the right-hand horizontal is a line drawn through the leading shoulder parallel with the pitch (Elliott et al., 1992).
7. **Side-on bowling action:** A shoulder alignment of 190° or less and a back foot angle of 280° or less where the right-hand horizontal is a line drawn through the leading shoulder parallel with the pitch (Elliott et al., 1992).

Significance of the study

The study will be significant in following ways:

1. It will help cricket coaches to choose a broadened exercise program to develop fast bowlers' bowling performance.

2. It will assist in reducing the injuries of fast bowlers and help trainers and coaches aid them.
3. The findings of the study may provide specific guidelines based on EMG processing for proper knowledge of strength training program for the fast bowlers.
4. It may be helpful for developing conditioning programs and selecting scientific methods for cricket players.
5. It may help researchers in the field of sports and physical education to carry out some insights for the further studies.

Chapter-II: Review of related literature

(Woolmer et al., 2008) Bob Woolmer has been a well-established name in cricket coaching. His book "Bob Woolmer's Art and Science of Cricket" is considered a definitive manual on cricket coaching. Bob Woolmer along with Tim Noakes put his wholesome effort into bringing out this book. A detailed explanation of almost every aspect involved in the game of cricket is given in the book. Our study's core- Bowling's many concepts and justifications are derived from this reference. The basic five phases of pace bowling and the difference between two distinct fast-bowling approaches i.e., front-on and side-on are picked from here.

(Ahamed et al., 2014) analyzed the available literature on EMG of cricket bowling and overhead throwing (OT) athletes. The selected databases were PubMed, Scopus, and Google Scholar up to December 2012. They primarily investigated the upper body muscles involved during OT athletic games and cricket bowling. The search identified 32 publications on OT athletes and 4 on cricket bowlers. They concluded that very little literature is available on cricket bowling and hence our topic came into consideration. Also, targeted muscles of the upper body are picked from this study.

(Elliott et al., 1992) investigated the influence of fast bowling and physical factors on radiologic features in high-performance young fast bowlers. 20 members of the Western Australian fast bowling squad participated in the study. They first underwent Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) to detect the presence of bony and intervertebral disk abnormalities. They were filmed laterally and vertically (directly above) as their front foot impacted a force platform during the delivery stride of the fast-bowling action. These subjects also performed selected physical capacity tests. The occurrence of abnormal radiologic data was then used to group the bowlers. A Mann-Whitney U-Test was used to find the statistical difference. They reached the conclusion that all the players who had experienced back pain had evidence of radiologic abnormality, whereas no bowler with a normal diagnosis complained of pain. Bowlers who possessed high release height relative to their standing height were predisposed to bony abnormality. The ball release height and biomechanical explanation of front-on and side-on bowling action are picked from this study.

(Foster et al., 1989) conducted a prospective study on 82 high-performance young male fast bowlers to assess back injuries to fast bowlers in cricket. The subjects were tested for selected kinanthropometric and physiological data immediately before the tournament season. Bowlers were filmed both laterally and vertically (directly above) as their front foot impacted

the force platform during delivery stride in bowling. The players then maintained a logbook throughout the season that detailed their training and playing programs. All cricket-related injuries over this season were assessed by a sports physician who used computerized tomography to assist in the diagnosis of spinal injuries. At the completion of this season, the players were divided into groups according to their injury status (Group 1--bony injury to a vertebra; Group 2--soft tissue injury to the back that caused the player to miss at least one game, and Group 3--no injuries). A one-way ANOVA to find out the statistical difference among the groups. Also, the Scheffe post hoc test was used to determine which group was significantly different. The results showed that 11 percent of players sustained a stress fracture to a vertebra (L4 to S1), while 27 percent sustained a soft tissue injury to the back. Bowlers with a low longitudinal foot arch were more likely to develop a stress fracture than those with a high arch. Shoulder depression and horizontal flexion strength for the preferred limb and quadriceps power in the non-preferred limb were also significantly related to back injuries. Results suggest that bowlers with the above physical characteristics, who bowl with these biomechanical techniques for extended periods, are predisposed to back injuries.

Chapter-III: Methodology

In this chapter, the procedure adopted for selection of subjects, selection of variables, reliability of data, criterion measures, procedure of testing, collection of data, and statistical techniques employing for analysis of data are described.

Selection of Subjects

For the purpose of the study, 20 subjects will be chosen through purposive sampling from Gwalior Division Cricket Association and LNIPE. Two groups i.e., Front-on action bowlers and side-on action bowlers will be formed. The group division will be done on the basis of biomechanical analysis of bowling action as per (Elliott et al., 1992) and groups will consist of 10 bowlers each. Only those who have represented district/state/national/west-zone/all-India will be chosen in order to ensure adequate level of technique and legal bowling action.

Selection of variables

For the purpose of the study, following variables will be chosen and taken care of:

A. Anthropometric

- Ball release height (in which the difference between release height of fingers while releasing the ball relative to standing height of the subject will be taken into consideration).

B. EMG Variables

- Muscles of upper body (bowling arm only)
  - Anterior deltoid
  - Pectoralis major
  - Latissimus dorsi
  - Trapezius

- Teres major
- Bicep brachii
- Tricep brachii

Reliability of Data

To obtain reliable measurement, the standard instrument which will be used for the purpose of the study, Free EMG, is available at the research laboratory of LNIPE, Gwalior. A high-speed motion analyzer camera will be used for videography, whichever best will be available during the study. Also, kinovea software will be used to assess anthropometric aspects of the study. The reliability of all the equipment will be as per ensured by the manufacturer. The research scholar will also ensure reliability by using test-retest method.

Criterion measures

- EMG recordings will be measured in micro volts; whereas, Root Mean Square (RMS) and Peak value will be considered for statistical analysis.
- Ball release height will be measured in meters.

Collection of data

Initially basic anthropometric measurements of subjects will be taken in standing position. Ball release height will be taken while at the release of the ball from fingers during bowling relative to standing height of the bowler. One full run-up and ball delivery's anthropometric readings will be considered for statistical analysis.

Prior to take EMG data, foreskin of the location of electrodes-placing site will be shaved and washed properly. Electrodes will be placed as per the EMG protocol on the selected muscles. Seven channels of the sEMG will be used for seven selected muscles. One full run-up and ball delivery's EMG readings will be considered for statistical analysis.

All the data will be collected and stored in Sports Biomechanics Department's EMG associated computer and also in researcher's own PC.

Administration of test

Data will be taken on moderate temperature days and not on a too hot or cold day. Also, collection of data on rainy days will be avoided. Adequate instructions will be given prior to the data collection. A proper warm-up and cooling down session will be conducted respectively before and after the data collection. Health status of all the subjects will be measured prior to the test. It will be made sure that both the groups perform at same time in order to eliminate climatic bias.

Though the subjects in the study will be selected from division/state/national/west-zone/all-India level cricket tournaments, however, cricket match-practice in-charge, supervisor and other experts will be requested to be present on the day of data collection in order to subjectively analyse the legal bowling action of the bowlers.

Statistical technique

To characterize the level of mean scores of muscle activation and anthropometric variable of subjects of both the groups of fast bowlers, descriptive statistics will be used.

To compare the mean scores of muscle activation and anthropometric measurements between both the groups, T-Test will be used. The 0.05 level of confidence will be fixed as the level of significance to test.

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